CLAIMS

1. Method for optical characterisation of at least one layer of material in an interval A of values taken by a function α of an optical wavelength λ, when λ varies in an interval of wavelengths, this layer being created on a substrate, this method being characterised in that it comprises the following stages:

1) we carry out a group of reflectometry and/or ellipsometry measurements over the interval A, this set of measurements leading to a measured spectrum, marked Ψ, and we choose the methods for calculating associated with the nature of the measurements and with the type of layer to be characterised;

2) we choose m initial values $\alpha_1 \ldots \alpha_m$ of the function α, belonging to this interval A, m being a whole number at least equal to 1, and we define an interval B as being the set of points α of the interval ranging from the smallest to the biggest number among $\alpha_1 \ldots \alpha_m$, when m is greater than 1, and as being the interval A when m equals 1;

3) we choose m complex initial values of a complex refraction index $n^*=n+jk$ for the m points α_i, i ranging from 1 to m;

4) when m is not 1, we choose an interpolation law which allows to calculate the refraction index $n(\alpha)$ of the material over the interval B, from the points (α_i, n_i), with $n_i=n(\alpha_i)$, i ranging from 1 to m, and when m equals 1, $n(\alpha)$ is taken equal to the number $n_1(\alpha_1)$ over the entire interval B;

5) we choose M variable parameters, M being less than or equal to 2m+1;

6) we choose an error function $Er(\Psi, \overline{\Psi})$ which characterises the difference between a measured spectrum Ψ and a theoretical spectrum $\overline{\Psi}$;

7) using a minimising function of $Er(\Psi, \overline{\Psi})$ with M parameters, we perform the following series of stages:

a) by applying the interpolation law of (α_i, n_i) over the interval B, we deduce $n(\alpha)$, α belonging to B;

b) by using $n(\alpha)$ and the thickness ε of the layer, and methods for calculating spectrums, we calculate a theoretical spectrum $\overline{\Psi}$ $(n(\alpha), \varepsilon)$;

c) we compare Ψ and $\overline{\Psi}$ by using $Er(\Psi, \overline{\Psi})$ and, if $Er(\Psi, \overline{\Psi})$ is sufficiently small, i.e. less than a predetermined value <u>e</u>, or is minimal, we go to stage e), otherwise we go to stage d);

d) we make the M variable parameters vary so as to tend to the minimum of Er $(\Psi, \overline{\Psi})$, and we return to stage a);

e) if $Er(\Psi, \overline{\Psi})$ is less than <u>e</u>, we then obtain a set of M variable parameters, for which Er $(\Psi, \overline{\Psi}$ $(n(\alpha, M), \varepsilon))$ is minimal and the refraction index is then taken equal to the last one obtained, and if Er $(\Psi, \overline{\Psi})$ is greater or equal to <u>e</u> we go to stage 8).

8) we increase the number m of initial values of the function α and we return to stage 2).

2. Method according to claim 1, in which we increase the number of initial values of the function α by adding one or several values to the extant initial values.

3. Method according to claim 1, in which we increase the number of initial values of the function α by replacing the extant initial values with new initial values whose number is greater than the number of extant initial values.

4. Method according to any one of claims 1 to 3, in which each interpolation law is chosen from among the linear interpolation laws, the cubic interpolation laws, the polynomial interpolation laws and the interpolation laws for example of spline function type.

5. Method according to any one of claims 1 to 4, in which the initial values of the function α are evenly distributed over the interval A, the distribution of the nodes thus being homogenous.

6. Method according to any one of claims 1 to 5, in which $\alpha(\lambda)$ is chosen among λ, $1/\lambda$ and hc/λ, where h is the Planck's constant and c the speed of light in vacuum.

7. Method according to any one of claims 1 to 6, in which we measure the error, at stage 6), over an interest interval C which is included in the interval B or equal to this interval B.

8. Method according to any one of claims 1 to 7, in which the M variable parameters are the real parts of the refraction indexes at points α_i, i ranging from 1 to m.

9. Method according to any one of claims 1 to 7, in which the M variable parameters are the imaginary parts of the refraction indexes at points α_i, i ranging from 1 to m.

10. Method according to any one of claims 1 to 7, in which the M variable parameters are constituted by the thickness of the material for which we are searching the refraction index.

11. Method for optical characterisation of at least one layer of a material in an interval of wavelengths [λ min, λ max], this layer being created on a substrate, method being characterised in that:

– we carry out a set of reflectometry and/or ellipsometry measurements, this set of measurements leading to a measured spectrum, marked Ψ;

– we choose m initial wavelengths $\lambda_1 \ldots \lambda_m$ belonging to this interval, m being a whole number at least equal to 1, we associate a refraction index to each wavelength;

– we choose an interpolation law at least for the refraction index of the material, for wavelengths lying between the initial wavelengths $\lambda_1 \ldots \lambda_m$;

– we choose M initial parameters, M being at least equal to m, namely an initial refraction index n_i for each initial wavelength λ_i, $1 \leq i \leq m$, the initial wavelengths being chosen so as to determine via interpolation at least the refraction index for any wavelength within the interval [λ min, λ max], the couples (λ_i, n_i) being called nodes;

– we choose reflectometry and ellipsometry methods of calculation;

– we also choose an error function Er, representative of the difference between two spectrums Ψ_1 and Ψ_2, the spectrums Ψ_1 and Ψ_2 being calculated or measured over a number of points greater than the number m of nodes;

– using the m initial wavelengths, the M initial parameters and the interpolation law, we implement the following optimisation process:

– we determine a theoretical spectrum, marked $\overline{\Psi}$, depending on the chosen methods of calculation, and on the index deduced via interpolation of its value at λ_i, i ranging from 1 to m, over the spectrum [λmin, λmax];

– we determine the error Er (Ψ, $\overline{\Psi}$), between the measured spectrum and the theoretical spectrum;

– we minimise this error by varying the position of the values of the unknown indexes and/or the thickness of the layer and/or the values of the refraction indexes with initial wavelengths, and we obtain a spectrum;

– we add other wavelengths to the initial wavelengths $\lambda i \ldots \lambda m$, the added wavelengths constituting new nodes;

– we repeat the method by choosing a number m′ of initial wavelengths, m′ being greater than m, and M′ initial parameters, M′ being greater than M, until the accuracy of each spectrum thus best represented is equal to a predetermined accuracy.

12. Method according to claim 11, in which m is at least equal to 2.

13. Method according to claim 11, in which m is at least equal to 1 and we choose equal initial refraction indexes.

14. Method according to any one of claims 11 to 13, in which the material is non absorbent and the number M is equal to m, the extinction coefficient of the material being set equal to 0.

15. Method according to any one of claims 11 to 13, in which :

– M is at least equal to 2m;

– we furthermore choose an interpolation law for the extinction coefficient of the material;

– for each initial wavelength λi, $1 \leq i \leq m$, furthermore we choose an initial extinction coefficient k_i, the initial wavelengths furthermore being chosen so as to be able to determine via interpolation the

extinction coefficient for any wavelength of interval [λ min, λ max];

– within the optimisation process, we minimise the error by also varying the values of the extinction coefficients at the initial wavelengths and the added wavelengths are furthermore placed so as to best represent the spectrum of the extinction coefficient of the material.

16. Method according to claim 15, in which m is equal to 1 and we choose equal initial refraction indexes and equal initial extinction coefficients.

17. Method according to any one of claims 11 to 16, in which the layer of material is thin, i.e. with a thickness less than the coherence length of the light used for measuring, we choose an additional initial parameter, namely an initial layer thickness, and in the optimisation process we minimise the error by also varying the value of the layer thickness.

18. Method according to any one of claims 11 to 16, in which the layer of material is thick, i.e. not thin, and M is at most equal to 2 m.

19. Method according to any one of claims 11 to 16, in which the thickness of the layer of material is known with a predetermined accuracy and M is at most equal to 2 m.

20. Method according to any one of claims 11 to 19, in which each interpolation law is chosen from among the linear interpolation laws, the cubic interpolation laws, the polynomial interpolation laws and the interpolation laws for example of spline function type.

21. Method according to any one of claims 11 to 20, in which the distribution of the nodes is homogenous.